REMARKS

Upon entry of this amendment, claims 23 – 49 are all the claims pending in the application. Claims 1 – 22 have been canceled by this amendment. Claims 23, 24, 26-32, 34 - 36, 38, 39, and 43 have been amended. Claims 46-49 have been added as new claims. No new matter has been added. In view of the above amendments and the following remarks, reconsideration and further examination are requested.

Applicants note that a number of editorial amendments have been made to the specification and abstract for grammatical and general readability purposes. No new matter has been added.

Applicants note that a replacement sheet is being submitted herewith for Figures 8A-8C. In the replacement sheet, Figure 8A, element number 602 has been added; Figure 8B, element number 602 and a Bragg grating have been added; and Figure 8C, element number 602 and a Bragg grating have been added. No new matter has been added.

The Examiner has objected to abstract of the disclosure for the reasons set forth on pages 2 and 3 of the Office Action. Applicants have amended the abstract in a manner to overcome this objection. The changes include editorial amendments that have been made for grammatical and general readability purposes. The original abstract has been replaced. No new matter has been added.

Based on the foregoing, Applicants respectfully request that the Examiner reconsider and withdraw the objection to the abstract.

Claim Rejections under 35 U.S.C. § 102

Claims 22-25, 29, 31-36, 38 and 42 have been rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 5,499,256 to Bischel et al. Applicants respectfully traverse this rejection on the following basis. A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art

reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

Bischel et al. discloses a polarized frequency-selective optical source. FIG. 8 of Bischel et al. shows a transverse-mode-selected external cavity laser structure 390 with mode conversion means 430. A resonant cavity is formed between the reflectors 412 and 424, with a laser exciter 400 and an integrated optical mode filter structure 420 aligned on the optical path within the optical cavity defined by the reflectors 412 and 424. A device according to this invention extracts a large portion of the wide stripe exciter power into a single transverse mode. Mode conversion means 430 produces single transverse mode operation. The tapered mode conversion means is optimally designed to couple power between the waveguide mode on one side and the lowest order transverse mode of the exciter on the other. Light propagating in the waveguide 440, after passing through the mode converter 430, is converted into the lowest order mode of the exciter. *See* column 17, lines 1 - 55.

The output facet of the diode laser gain region is coated with an anti-reflection (AR) coating 414 and is butt-coupled to the mode filter structure 420. Embedded in the mode filter structure 420 is a mode reshaper 430, also called the mode reshaping means, which is preferably in the form of an adiabatic tapered horn waveguide region having at one end a broad nozzle, called the first port, acting as an interface with the output AR coated facet 414 of the diode laser gain media, also called the matching multimode port of the multimode laser exciter, and at the other end a narrow neck, called the second port, matched to the single mode waveguide 440. *See* column 17, line 64 to column 18, line 18.

However, Bischel et al. fail to teach or suggest each and every element of the independent claims, *inter alia*,

"...laser capable of exciting a plurality of lateral modes... a wavelength selecting filter through which the light exiting an end face of the single-mode waveguide passes, and through which a portion of the light transmitted by the single-mode waveguide is fed back to an active layer of the semiconductor laser using a same exit path,

wherein an oscillation mode of the semiconductor laser is limited by the light that has been fed back, so that the semiconductor laser oscillates in a generally single longitudinal mode

and a generally single lateral mode,..." [*Amended independent claim 23,* which was formerly dependent on canceled independent claim 22]

"...laser capable of exciting a plurality of lateral modes... a wavelength selecting filter through which the light exiting an end face of the single-mode waveguide passes, and through which a portion of the light transmitted by the single-mode waveguide is fed back to an active layer of the semiconductor laser using a same exit path,

wherein an oscillation mode of the semiconductor laser is limited by the light that has been fed back, so that the semiconductor laser oscillates in a generally single longitudinal mode and a generally single lateral mode..." [*Amended independent claim 24,* which was formerly dependent on canceled independent claim 22]

"...laser capable of exciting a plurality of lateral modes...single-mode waveguide..., and having a periodic polarization inversion structure; and a wavelength selecting filter through which the light exiting an end face of the single-mode waveguide passes, and through which a portion of the light transmitted by the single-mode waveguide is fed back to an active layer of the semiconductor laser using a same exit path,

wherein the oscillation mode of the semiconductor laser is limited by the light that has been fed back, so that the semiconductor laser oscillates in a generally single longitudinal mode and a generally single lateral mode, and

wherein the portion of the light that passes from the semiconductor laser through the single-mode waveguide is subjected to wavelength conversion by the polarization inversion structure." [*Amended independent claim 31,* which was formerly dependent on canceled independent claim 22]

"...laser capable of exciting a plurality of lateral modes...a tapered waveguide having an incident end face to which light exiting from the semiconductor laser is coupled; a band pass filter through which a portion of the light transmitted by the single-mode waveguide passes; and a reflector that reflects the light transmitted through the band pass filter and feeds part of the light back to an active layer of the semiconductor laser using a same exit path,

wherein the oscillation mode of the semiconductor laser is limited by the light that has been fed back, so that the semiconductor laser oscillates in a generally single longitudinal mode

and a generally single lateral mode." [*Amended independent claim 32,* which was formerly dependent on dependent claim 29]

"...laser capable of exciting a plurality of lateral modes... a reflector that reflects a portion of the light transmitted from the single-mode waveguide and feeds the portion of the light back to an active layer of the semiconductor laser using a same exit path,

wherein the oscillation mode of the semiconductor laser is limited by the light that has been fed back, so that the semiconductor laser oscillates in a generally single longitudinal mode and a generally single lateral mode." [*Amended independent claim 35*]

In particular, Bischel et al. do not disclose a coherent light source in which a semiconductor laser oscillates in a generally single longitudinal mode and a generally single lateral mode, *inter alia*, as recited in the amended independent claims. Instead, in Bischel et al., since the optical cavity contains the single transverse mode waveguide 440, <u>oscillation occurs only on the transverse mode</u> of this waveguide (as it may be transported through the rest of the optical structure). *See* column 17, lines 1 - 55. In Bischel et al., since a large portion of the wide stripe exciter power is extracted into a single transverse mode as a multi-mode gain region 410, coupling with the single-mode waveguide 440 is largely deteriorated and all other modes <u>have significant loss and will not reach lasing threshold</u> in a properly designed system as discussed at column 18, lines 19 - 44, for example.

One of the advantages of the present invention is to couple the laser light to the single-mode optical waveguide via a bulk optical system. An example of a bulk material used is a volume grating which has a periodic change in refractive index. It is composed of a material having a UV-curing material as a main component, and the interference of light is utilized to form a grating structure. Bragg reflection produced by a periodic refractive index grating formed in bulk results in narrow-band reflection characteristics with a narrow half band width. *See* page 10, lines 5 – 14 of the specification of the instant application. Another advantage of the present invention is to improve the coupling efficiency between the wide strip laser and the single-mode optical waveguide.

In contrast with Bischel et al., according to independent claim 23 (which was formerly dependent on canceled independent claim 22) of the instant application, the wide stripe

semiconductor laser device and the single-mode waveguide are coupled via a shaping optical system (e.g., mode converter 102 in Figs. 1, 3A, and 3B of the instant application). Light is fed back from the end face of the single-mode waveguide so that the single-mode waveguide and the wide stripe semiconductor laser device constitute a high-output (resonance structure). As a result, high-power light is emitted from the optical waveguide including the longitudinal mode and the transverse mode, which has been shaped as a generally single-mode.

Regarding independent claim 24, light is also fed back to the multi-mode semiconductor laser via a wavelength selecting filter that has narrow-band reflection characteristics. Therefore, it is possible to change the wavelength of transparency by changing the angle of the filter (e.g., Figs 7A and 7B of the instant application). Thereby, the oscillation wavelength of the laser can be adjusted to a wavelength with which the efficiency of the oscillation wavelength becomes maximum. It is also possible to use it as a laser source that can change the wavelength.

Further, regarding independent claim 31, the optical waveguide includes a periodic polarization inversion structure therein. Accordingly, it is possible to convert the wavelength of the laser light at high efficiency. However, a wavelength conversion element has extremely narrow tolerance for the wavelengths that can be converted. Therefore, the longitudinal and lateral modes both need to be in single mode. *See* page 13, line 31 to page 14, line 9 of the specification of the instant application.

Furthermore, regarding independent claim 32, with a band pass filter, the oscillation wavelength of the wide stripe laser can be changed. By changing the angle of the filter, it is possible to change the transparent wavelength on the order of a few tens nanometer. By making use of this feature, it is possible to adjust the oscillation wavelength of the semiconductor in a wide range by changing the feedback wavelength to the semiconductor laser. It is also possible to optimally improve the efficiency of the wavelength conversion by changing the oscillation wavelength of the semiconductor laser, thereby increasing optical feedback. Further, since the wavelength can be controlled to an optimum value in response to the change of the surrounding temperature, stable output is possible. In addition, the efficiency of the wavelength conversion can be adjusted by changing the angle of the filter. Still further, the power of the guided light is extremely high at the exit end face of the tapered waveguide. Therefore, the longitudinal and

lateral modes are both selected by the tapered waveguide 503 and the band pass filter 510, which fixes the semiconductor laser 501 to single mode for both the longitudinal mode and the lateral mode; affording stable and highly efficient coupling with the single-mode waveguide 509. Still even further, with a grating structure as the waveguide formed integrally with the filter (e.g., Fig. 5), the reflection wavelength is fixed, and thus the output of the semiconductor laser can be modulated faster due to this integration. Therefore, even if the wavelength is adjusted by changing the temperature, for example, the range of wavelength change is very narrow (e.g., a few nm).

Even further, regarding independent claim 35, the Bragg reflection structure is formed to the semiconductor laser (e.g., Figs. 8A - 8C). Since the loss is small in a semiconductor laser compared to a case of reflecting light using other optical elements, it is advantageous to gain better power efficiency. Also, it is possible to make the output of the wavelength locking (fixing) laser higher according to the present invention. In the prior art, if the reflection grating is formed in the wide stripe laser, it is possible to fix the oscillation wavelength. However, the wider the stripe is, the more actively the transverse mode is oscillated in the multi-mode, generating many propagation modes. Accordingly, the interaction between the modes of the semiconductor laser becomes weak, so that it becomes difficult to fix the oscillation wavelength to the Bragg wavelength. In other words, the range in which the wavelength can be fixed by the reflection grating is limited by the stripe width of the semiconductor laser. Since high output is limited to the stripe width, the output of the semiconductor laser having a locked wavelength is limited to a few watts. According to the present invention, the light for suppressing the transverse mode is fed back to the wide stripe semiconductor laser having a grating structure. Accordingly, it is possible to reduce the number of the transverse modes of the semiconductor laser. As a result, even in a wide stripe laser having a width of more than 200 μm, it becomes possible to obtain the advantage of the wavelength locking effect due to the grating by restricting the transverse modes, thereby realizing a wavelength locking laser with a high output.

Accordingly, in contrast, the oscillation mode of the semiconductor laser in Bischel et al. is not limited by the light that has been fed back, so that the semiconductor laser oscillates a generally single longitudinal mode and a generally single lateral mode. Instead, the waveguide

segment 440 in Bischel et al. supports only a single transverse optical mode. Since the waveguide segment 440 supports only a single transverse optical mode, all other possible spatial modes that are supported by the wide multi-mode gain region 410 have significant loss and will not reach lasing threshold in a properly designed system. *See* column 18, lines 19 – 44 of Bischel et al. Further, as discussed in Bischel et al. regarding Fig. 1, the transverse magnetic (TM) polarized optical signal reflected off of the feedback reflector 124 is directed back through the converter 130 and is converted back into a transverse electric (TE) polarized optical signal which is propagated back along the first waveguide 132, and which is coupled into the diode laser gain medium 100. Furthermore, the TE polarized optical signal reflected off of the feedback reflector 124 is directed back through the converter 130 and is converted back into a TM polarized optical signal to be propagated along the first waveguide 132, coupling and frequency stabilizing the diode laser gain medium 100.

In addition, the waveguide 140/440/540/640 (which supports a single polarization only) in Bischel et al. is embedded within the polarization selective wavelength filter 120/420/520/620. *See* column 6, line 60 to column 7, line 9 of Bischel et al. This arrangement is used for frequency stabilization and selection. In contradistinction, in none of the embodiments of the present invention, is the waveguide and filter arranged in such a manner. In the instant application, the angle of the narrow-band filter is changed in order to change the wavelength of transparency. However, in Bischel et al., large angle grating reflector 354 needs TM polarization for high efficiency because the Brewster angle is at an angle of incidence of nearly 45°. The reflector also needs frequency selectivity because only a specific wavelength will reflect at the design angle, due to the dispersion of the grating. In other words, in Bischel et al., the TE-TM wavelength selective filter operates intracavity with a TE polarized exciter and a TM polarized waveguide, and selects only a single wavelength for oscillation. *See* column 16, lines 24 to 44 and column 22, lines 19 to 46.

Therefore, as Bischel et al. fails to anticipate independent claims 23 and 23 (which now include the subject matter of canceled claim 22), 31 (which now includes some of the subject matter of canceled claim 22), 32, and 35, Applicants respectfully request that the rejection be withdrawn.

Claims 25, 29, 33, 34, and 36, 38 and 42 depend from one of claims 23, 24, 31, 32, and 35 and are therefore considered patentable at least by virtue of their dependency.

Claim Rejections under 35 U.S.C. § 103(a)

Claims 26 – 28 and 30 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over Bischel et al. Claim 37 has been rejected under 35 U.S.C. § 103(a) as being unpatentable over Bischel et al. in view of U.S. Patent No. 6,388,799 to Arnon et al. Claims 39-41 and 43-45 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over Bischel et al. in view of U.S. Patent No. 6,489,985 to Brodsky et al.

Applicants respectfully traverse these rejections on the following basis. To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

Bischel et al. has been discussed above.

Claims 26-28 and 30 depend from one of claims 23 and 24. Accordingly, Applicants submit that claims 26-28 and 30 are patentable at least by virtue of their dependency.

Regarding claim 37, Arnone et al. has been cited to cure the deficiencies of Bischel et al. Arnone et al. teaches an optical device and imaging system. Even *assuming arguendo* that Arnone et al. teaches a dichroic mirror, this secondary reference fails to cure the deficiencies of Bischel et al. regarding *inter alia*, a wavelength selecting filter and the oscillation mode of the semiconductor laser.

Claim 37 depends from claim 35. Applicants submit that Arnone et al. fails to cure the deficiencies of Bischel et al., as discussed above, with respect to claim 35. Accordingly, Applicants submit that claim 37 is patentable at least by virtue of its dependency.

Regarding claims 39-41 and 43-45, Brodsky et al. has been cited to cure the deficiencies of Bischel et al. Brodsky et al. teaches a laser marking system and method of energy control. Even *assuming arguendo* that Brodsky et al. teaches a two-dimensional image, this secondary reference fails to cure the deficiencies of Bischel et al. regarding *inter alia*, a wavelength selecting filter and the oscillation mode of the semiconductor laser.

Claims 39-41 and 43-45 depend from one of claims 23 and 35. Applicants submit that Brodsky et al. fails to cure the deficiencies of Bischel et al., as discussed above, with respect to claim 23 or 35. Accordingly, Applicants submit that claims 39-41 and 43-45 are patentable at least by virtue of their dependency.

New Claims

Claims 46-49 have been added as new claims. Claims 46-49 depend from claim 32 and are therefore considered patentable at least by virtue of their dependency. Support for the newly added claims can be found for example originally filed claims 38-41 and 42-45.

Conclusion

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may best be resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

Respectfully submitted,

Kiminori MIZUUCHI et al.

By: ____________________
Teresa M. Arroyo
Registration No. 50,015
Attorney for Applicants

DMO/TMA/nrj
Washington, D.C. 20006-1021
Telephone (202) 721-8200
Facsimile (202) 721-8250
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